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[ETD 15: Rotating Machinery]

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कार्बन ब्रुशों के लिए सुनम्य चालकों की विशिष्टि

Indian Standard

FLEXIBLE CONDUCTORS FOR CARBON BRUSHES—SPECIFICATION

UDC 621·315·34 : 621·313·047·43

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

December 1992 **Price Group 2**

Rotating Machinery Sectional Committee, ET 15

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Rotating Machinery Sectional Committee had been approved by the Electrotechnical Division Council.

The carbon brush manufacture has been progressing steadily in the country and this standard has been prepared with a view to provide guidance to flexible conductor manufacturers and the user in the choice of flexible conductors used with carbon brushes.

The requirements of the brush material and the brushes for electrical machines have been specified in the following standards:

a) IS 13584 : 1992 Brush materials for electrical machinery [*Superseding* IS 3003 (Part 2)].

b) IS 13466 : 1992 Brushes for electrical machinery (*Superseding* IS 3003 Parts 3 and 4).

The guidance for selection and use of carbon brushes for applications in rotating electrical machines is given in IS 9919 : 1981 'Guide for selection and use of carbon brushes for applications in rotating electrical machines'.

While preparing this standard, assistance has been derived from IS 8130 : 1984 'Conductors for insulated electric cables and flexible cords (*first revision*)' and JIS C 2802 : 1970 'Dimensions of brushes for electric machines'.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

FLEXIBLE CONDUCTORS FOR CARBON BRUSHES—SPECIFICATION

1 SCOPE

This standard specifies the requirements and construction of flexible conductors for carbon brushes used in electric machines.

2 REFERENCE STANDARDS

The list of Indian Standards given in Annex A are referred to in this standard.

3 TERMINOLOGY

3.1 For the purpose of this standard, the following definitions in addition to those covered in IS 1885 (Part 32) : 1972 and IS 13586 : 1992 shall apply.

3.1.1 *Wire*

Made of a metallic material, uniform in diameter and circular in cross section.

3.1.2 *Bunch of Wires*

A group of wires of uniform size of the same material or different materials, the diameter of the wires being sufficiently small to afford flexibility.

3.1.3 *Stranding*

A group of wire bunches twisted together.

3.1.4 *Flexible Conductor for Brush*

A flexible conductor containing one or more strandings which is fixed to the carbon brush.

4 MATERIAL

4.1 Copper Wires

4.1.1 Wires shall be made of electrolytic annealed copper.

4.1.2 The material shall have chemical composition for ETP copper as per IS 191 (Part 5) : 1980.

4.1.3 Standard values for copper at 20°C are given below:

Electrical resistivity for 100 % conductivity	0·017 241 ohm mm^2/m
Density	8·89 g/cm^3

4.1.4 Copper wires shall meet the requirements specified in Table 1.

4.2 Stainless Steel Wires

Stainless steel wire shall conform to IS 4454 (Part 4) : 1975, Grade 1, in all respects including testing and packing.

5 BRUSH FLEXIBLE

5.1 The brush flexible shall be reinforced with stainless steel wires, if required by the user.

5.2 The flexible shall be clean, compact, reasonably uniform in size and shape.

5.3 If required by the user, the copper wires shall be tinned or silvered.

5.4 The wires shall be bright and clean. It shall be free from blisters, slivers, scale, fins, spills, cracks and other defects.

5.5 The flexible conductors of standard sizes shall meet the requirements specified in Table 2.

5.6 Unless otherwise specified, tolerances shall be in accordance with Table 3.

Table 1 Plain Copper Wires

(*Clauses* 4.1.4 *and* 6.3.3)

Diameter	**Tolerance on Diameter**	**Minimum Elongation**	**Minimum Electrical Conductivity**	**Nominal**		
				Sectional Area	Weight	Resistance at 20°C
mm	mm	%	%	mm^2	kg/km	ohm/km
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0·05	± 0·003	10	97	0·001 96	0·017 46	9 050
0·07	± 0·003	10	98	0·003 35	0·034 21	4 572
0·10	± 0·008	15	98	0·007 85	0·069 82	2 240
0·12	± 0·008	15	98	0·011 31	0·100 50	1 556

Table 2 Details of Flexibles

(*Clauses* 5.5 *and* 6.4.3)

Nominal Sectional Area	**Maximum Overall Diameter**	**Constructional Details**			**Minimum Weight**	**Maximum Resistance at 20°C**
		Diameter of Each Wire	Number of Wires	Formation *S* × *B* × *W*		
mm²	mm	mm			g/m	ohm/m
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Copper Flexibles						
0·06	0·40	0·05	31	1 × 31	0·48	0·327 5
0·10	0·50	0·05	51	3 × 17	0·79	0·199 1
0·15	0·60	0·05	75	3 × 25	1·15	0·135 4
0·20	0·70	0·05	102	3 × 34	1·60	0·099 5
0·25	0·80	0·05	126	3 × 42	2·00	0·080 6
0·35	0·90	0·05	177	3 × 59	2·70	0·057 4
0·50	1·00	0·05	252	7 × 36	3·90	0·040 3
0·75	1·30	0 05	385	7 × 55	6·00	0·026 4
1·00	1·50	0·05	511	7 × 73	7·90	0·019 9
1·25	1·70	0·07	322	7 × 46	10·20	0·015 4
1·50	1·90	0·07	392	7 × 56	12·40	0·012 6
2 00	2·20	0·07	518	7 × 74	16·40	0·009 5
2·50	2·40	0·07	651	7 × 93	20·60	0·007 6
		0·10	315	7 × 45	18·80	0·008 3
		0·12	224	7 × 32	19·80	0·007 9
3·20	2·70	0·07	840	7 × 3 × 40	26 60	0·005 9
		0·10	406	7 × 58	24·20	0·006 5
		0·12	280	7 × 40	24·70	0·006 3
4·00	3·10	0·07	1 029	7 × 3 × 49	32·50	0·004 8
		0·10	511	7 × 73	30·50	0 005 1
		0·12	357	7 × 51	31·50	0·005 0
6·00	3·80	0·07	1 554	7 × 3 × 74	49·10	0·003 2
		0·10	763	7 × 109	45·50	0·003 4
		0·12	532	7 × 76	47·00	0·003 3
8·00	4·30	0·07	2 079	7 × 3 × 99	65·70	0·002 4
		0·10	1 022	7 × 146	60·90	0·002 6
		0·12	707	7 × 101	62·50	0·002 5
10·00	4·80	0·07	2 604	7 × 3 × 124	82·30	0·001 9
		0·10	1 274	7 × 182	76·00	0·002 1
		0·12	882	7 × 126	77·90	0·002 0
12·50	5·30	0·07	3 255	7 × 3 × 155	102·90	0·001 5
		0·10	1 589	7 × 227	94·70	0·001 7
		0·12	1 106	7 × 158	97·70	0·001 6
16·00	6·00	0·07	4 158	7 × 3 × 198	131·50	0·001 2
		0·10	2 037	7 × 291	121·50	0·001 3
		0·12	1 414	7 × 202	125·00	0·001 3
Reinforced Flexibles						
1·00	1·50	0·10	126	7 × 18 (15Cu + 3 SS)	7·50	0·024 4
1·25	1·70	0·10	161	7 × 23 (20Cu + 3 SS)	9·60	0·018 3
1·50	1·90	0·10	189	7 × 27 (23Cu + 4 SS)	11·30	0·015 9
2·00	2·20	0·12	175	7 × 25 (21Cu + 4 SS)	15·50	0·011 8
2·10	2·30	0·12	189	7 × 27 (23Cu + 4 SS)	16·70	0·010 7
3·20	2·70	0·12	280	7 × 40 (34Cu + 6 SS)	24·80	0·007 3
4·00	3·10	0·12	357	7 × 51 (43Cu + 8 SS)	31·60	0 005 7
4·60	3·30	0·12	406	7 × 58 (49Cu + 9 SS)	35·90	0·005 0
6·00	3·80	0·12	532	7 × 76 (65Cu + 11 SS)	47·10	0·003 8
8·00	4 30	0·12	707	7 × 101 (86Cu + 15 SS)	62·60	0 002 9
10·00	4·80	0·12	882	7 × 126 (107Cu + 19 SS)	78·10	0·002 3

NOTES

1 Abbreviations:

S = Strands per flexible

B = Wire bunches per strand

W = Wires per bunch

2 Above data pertains to the copper wires without tin or silver coatings. Details for tinned and silvered copper wires may be mutually agreed between user and the manufacturer.

Table 3 Tolerances on Brush Flexibles

(*Clause* 5.6)

Nominal Sectional Area mm²	0 to 0·5	0·75 to 2·0	2·5 to 16·0
Wires per flexible	± 2 %	± 2 %	± 2 %
Flexible Diameter, mm	± 0·10	± 0·15	± 0·20

6 TESTS AND REQUIREMENTS

6.1 Tests specified shall normally be made at the manufacturer's premises.

6.2 Classification of Tests

6.2.1 *Type Tests*

6.2.1.1 Type tests for copper wires shall consist of the following:

a) Persulphate test (for tinned copper only),

b) Annealing test,

c) Electric resistance test,

d) Measurement of weight,

e) Measurement of conductivity at 20°C, and

f) Test to determine chemical composition for ETP copper.

6.2.1.2 Type tests for flexibles shall consist of the following:

a) Construction,

b) Measurement of diameter,

c) Electric resistance test, and

d) Measurement of weight.

6.2.2 *Routine Test*

6.2.2.1 Routine tests for copper wires shall consist of the following:

a) Visual test,

b) Electric resistance test,

c) Measurement of weight,

d) Measurement of conductivity at 20°C, and

e) Annealing test.

6.2.2.2 Routine tests for flexibles shall consist of the following:

a) Visual test,

b) Electric resistance test, and

c) Measurement of weight.

6.3 Tests for Copper Wires

6.3.1 *Visual Test*

The wires shall be checked visually and by hand touch for freedom of defects listed under **5.4**.

6.3.2 *Persulphate Test (for Tinned Copper only)*

The test shall be carried out in accordance with method B given in IS 10810 (Part 4) : 1984. The mass of copper dissolved shall not exceed 5 g/m.

6.3.3 *Annealing Test (Before Stranding)*

This test shall be carried out in accordance with IS 10810 (Part 1) : 1984. The elongation shall not be less than the appropriate value given in Table 1.

6.3.4 *Electric Resistance Test*

This test shall be carried out in accordance with IS 10810 (Part 5) : 1984. The dc resistance of the conductor shall be measured at room temperature and corrected to 20°C.

6.3.5 *Measurement of Weight*

Measurement of weight shall be carried out on the length on which the electric resistance is measured. The balance used for measurement of the weight shall be of suitable accuracy corresponding to the measuring weight.

6.3.6 *Measurement of Conductivity at 20°C*

The conductivity may be measured directly with a suitable conductivity bridge of calculated based on results of resistance and weight as follows:

$$\text{Percent Conductivity} = \frac{0{\cdot}017\,241 \times 8{\cdot}89 \times L}{R \times W} \times 100$$

where

R = Electric resistance at 20°C (ohms),

W = Weight (g), and

L = Length (m).

6.4 Tests for Flexible

6.4.1 *Visual Test*

The flexible shall be checked visually and by hand touch for compactness and uniformity of size and shape.

6.4.2 *Construction*

Construction test shall be carried out on a test piece and diameter of the component wire and number of the component wires shall be checked for conformity to this specification.

6.4.3 *Diameter*

Maximum overall diameter shall be ascertained by passing the flexible through a ring having internal diameter specified in Table 2.

6.4.4 *Electric Resistance Test*

This test shall be carried out in accordance with IS 10810 (Part 5) : 1984. The dc resistance of the flexible shall be measured at room temperature and corrected to 20°C.

6.4.5 *Measurement of Weight*

Measurement of weight shall be carried out on the length on which the electric resistance is measured. The balance used for measurement of the weight shall be of suitable accuracy corresponding to the measuring weight.

7 PACKING AND MARKING

7.1 The conductor shall either be wound on reels or supplied in coils, packed and labelled. The label shall have the following information:

a) Name of the manufacturer,
b) Size of the conductor, and
c) Length of the conductor.

7.1.1 The conductor may also be marked with Standard Mark.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
191 (Part 5) : 1980	Specification for copper (*third revision*)
1885 (Part 32) : 1972	Electrotechnical vocabulary: Part 32 Cables, conductors and accessories for electrical supply
4454 (Part 4) : 1975	Steel wires for cold formed springs: Part 4 Stainless spring steel wire for normal corrosion resistance (*first revision*)
10810 (Part 1) : 1984	Methods of test for cables: Part 1 Annealing test for wires used in conductors
(Part 4) : 1984	Part 4 Persulphate test of conductor
(Part 5) : 1984	Part 5 Conductor resistance test
13586 : 1992	Definitions and nomenclature for carbon brushes, brush holders, commutators and ship-rings for electrical machinery [Superseding IS 3003 (Part 1) : 1977]

Standard Mark

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